

CLAIMS

1. A method for conducting harmonic imaging without using a matched decoding and compressing filter comprising:

transmitting a coded pulse having a time bandwidth product greater than about 1 and a phase inverted version of said coded pulse;

receiving at least a backscattered echo of said coded pulse and at least a backscattered echo of said phase inverted version of said coded pulse; and

coherently summing said at least a backscattered echo of said coded pulse with said at least a backscattered echo of said phase inverted version of said coded pulse.

2. The method of Claim 1 comprising decoding said backscattered echo of said coded pulse and said backscattered echo of said phase inverted version of said coded pulse, wherein said decoding occurs naturally through:

A. propagation of at least said coded pulse and said phase inverted version of said coded pulse inside tissue; and

B. said coherent summation of said backscattered echo of said coded pulse with said backscattered echo of said phase inverted version of said coded pulse.

3. The method of Claim 1 further comprising filtering said backscattered echoes of said coded pulse and said phase inverted version of said coded pulse before or after said coherent summing using a filter which passes at least one selected frequency and blocks at least one other frequency.

4. The method of claim 3 wherein said filter comprises at least one of a bandpass filter, a base band low pass filter and a mismatched filter.

5. The method of Claim 1 wherein at least said coded pulse comprises at least one ultrawide band frequency modulated pulse having a bandwidth greater than about 80%.

6. The method of Claim 1 wherein at least said coded pulse comprises at least one frequency modulated pulse having a bandwidth less than about 80%.

7. The method of Claim 1 wherein at least said coded pulse is at least one of a linear frequency modulated pulse and non-linear frequency modulated pulse.

8. The method of Claim 1 wherein said coded pulse comprises at least one of an amplitude modulated pulse and a frequency modulated pulse.

9. The method of Claim 1 wherein a center frequency of said at least one pulse is selected such that a second harmonic signal is generated having a center frequency falling within a predetermined bandwidth range of a probe.

10. A method for conducting harmonic imaging using an ultrasound machine without using a matched decoding and compressing filter comprising:

transmitting at least one coded pulse having a time bandwidth product greater than about 1 along a transmit beam path;

receiving at least two backscattered echoes of said transmitted coded pulse along opposing sides of said transmit beam path;

forming at least one phase inverted version of said at least one coded pulse;

transmitting said at least one phase inverted version of said at least one coded pulse;

receiving at least two backscattered echoes of said at least one phase inverted version of said coded pulse along opposing sides of a transmit beam path; and

coherently summing said at least two backscattered echoes of said coded pulse with said at least two backscattered echoes of said phase inverted version of said coded pulse forming at least two coherent sums.

11. The method of Claim 10 comprising decoding said backscattered echoes of said coded pulses and said backscattered echoes of said phase inverted version of said coded pulses, wherein said decoding occurs naturally through:

A. propagation of said at least one coded pulse and said at least one phase inverted version of said at least one coded pulse in tissue; and

B. said coherent summation of said at least two backscattered echoes of said transmitted coded pulse with said at least two backscattered echoes of said at least one phase inverted version of said coded pulse.

12. The method of Claim 10 further comprising filtering at least one of said at least two backscattered echoes of said coded pulse and said at least two backscattered echoes of said phase inverted version of said coded pulse before or after said coherent summing using a filter which passes at least one selected frequency and blocks at least one other frequency.

13. The method of Claim 12 wherein said filter comprises at least one of a bandpass filter, a base band low pass filter and a mismatched filter.

14. The method of Claim 10, wherein said opposing sides comprise right and left sides of said transmit beam path.

15. The method of Claim 10 wherein at least said coded pulse comprises at least one ultrawide band frequency modulated pulse.

16. The method of Claim 15 wherein said ultrawide band frequency modulated pulse has a bandwidth greater than about 80%.

17. The method of Claim 15 wherein said coded pulse comprises at least one frequency modulated pulse having a bandwidth less than about 80%.

18. The method of Claim 10 wherein at least said coded pulse is at least one of a linear frequency modulated pulse and non-linear frequency modulated pulse.

19. The method of Claim 10 wherein at least said coded pulse is at least one of amplitude modulated pulse and frequency modulated pulse.

20. A method for conducting harmonic imaging using an ultrasound machine without using a matched decoding and compressing filter comprising:

transmitting at least one coded pulse having a time bandwidth product greater than about one along a first beam path;

receiving at least one backscattered echo of said transmitted coded pulse;

forming at least one phase inverted version of said at least one coded pulse;

transmitting said at least one phase inverted version of said at least one coded pulse along a second beam path;

receiving at least one backscattered echo of said at least one phase inverted version of said coded pulse; and

coherently summing said at least one backscattered echo of said coded pulse with said at least one backscattered echo of said phase inverted version of said coded pulse, forming at least a received echo along a third beam path in spaced relationship to said first and second beam paths.

21. The method of Claim 20 comprising decoding said backscattered echo of said coded pulse and said backscattered echo of said phase inverted version of said coded pulse, wherein said decoding occurs naturally through:

A. propagation of said at least one coded pulse and said at least one phase inverted version of said at least one coded pulse in tissue; and

B. said coherent summation of said at least one backscattered echo of said coded pulse with said at least one backscattered echo of said phase inverted version of said coded pulse.

22. The method of Claim 20 further comprises filtering at least one of said at least one backscattered echo of said coded pulse and said at least one backscattered echo of said phase inverted version of said coded pulse before or after said coherent summation using a filter which passes at least one selected frequency and blocks at least one other frequency.

23. The method of Claim 22 wherein said filter comprises at least one of a bandpass filter, a base band low pass filter and a mismatched filter.

24. The method of Claim 20 wherein at least said second beam path is spatially adjacent to at least said first beam path.

25. The method of Claim 20 wherein at least said third beam path is spaced between said first and second beam paths.

26. The method of Claim 20 wherein at least said coded pulse comprises at least one ultrawide band frequency modulated pulse having a bandwidth greater than about 80%.

27. The method of Claim 20 wherein at least said coded pulse comprises at least one frequency modulated pulse having a bandwidth less than about 80%.

28. The method of Claim 20 wherein at least said coded pulse is at least one of a linear frequency modulated pulse and non-linear frequency modulated pulse.

29. The method of Claim 20 wherein at least said coded pulse is at least one of amplitude modulated pulse and a frequency modulated pulse.

30. A method for conducting harmonic imaging using an ultrasound machine without using a matched decoding and compressing filter comprising:

simultaneously transmitting at least two coded pulses having a time bandwidth product greater than about 1 along two separate beam paths;

receiving at least two backscattered echoes of said two transmitted coded pulses;

forming at least two phase inverted versions of said coded pulses;

simultaneously transmitting said two phase inverted versions of said coded pulses along said two beam paths;

receiving at least two backscattered echoes of said two phase inverted versions of said coded pulses; and

coherently summing said at least two backscattered echoes of said coded pulses with said at least two backscattered echoes of said two phase inverted versions of said coded pulses, forming two summed echoes along said two beam paths.

31. The method of Claim 30 further comprising decoding said backscattered echoes of said coded pulses and said backscattered echoes of said phase inverted version of said coded pulses, wherein said decoding occurs naturally through:

A. propagation of said at least two coded pulses and said at least two phase inverted versions of said coded pulses in tissue; and

B. said coherent summation of said at least said two backscattered echoes of said coded pulses with said two backscattered echoes of said two phase inverted versions of said coded pulses.

32. The method of Claim 30 further comprises filtering at least one of said two backscattered echoes of said coded pulses and said two backscattered echoes of said two phase inverted versions of said coded pulses before or after said coherent summation using a filter which passes at least one selected frequency and blocks at least one other frequency.

33. The method of Claim 32 wherein said filter comprises at least one of a bandpass filter, a base band low pass filter and a mismatched filter.

34. The method of Claim 30 wherein said two beam paths are spatially separated.

35. The method of Claim 30 wherein said coded pulses comprise ultrawide band frequency modulated pulses having a bandwidth greater than about 80%.

36. The method of Claim 30 wherein said coded pulses comprise frequency modulated pulses having a bandwidth less than about 80%.

37. An ultrasound apparatus for providing tissue harmonic imaging of tissue using natural decoded coded excitation and without using a matched decoding and compressing filter, said apparatus comprising:

a probe arranged to transmit at least one coded pulse and a phase inverted version of said coded pulse into tissue, generating at least one received signal in response to at least one echo of said coded pulse and at least one echo of said phase inverted versions of said coded pulse backscattered from the tissue; and

a coherent summation module adapted to coherently summing at least one of said backscattered echoes of said coded pulse with at least one of said backscattered echoes of said phase inverted version of said coded pulse forming at least one coherent sum.

38. The apparatus of Claim 37 further comprising a filtering module coupled to at least said coherent summation module and adapted to pass at least one selected frequency and block at least one other frequency.

39. The apparatus of Claim 37 further comprising at least one multiline transmitter adapted to transmit at least a plurality of pulses along at least one of a beam path and a plurality of beam paths.

40. The apparatus of Claim 37 further comprising at least one multi-line receiver adapted to receive at least one echo or a plurality of echoes of a transmitted pulse along a beam path or a plurality of beams paths.